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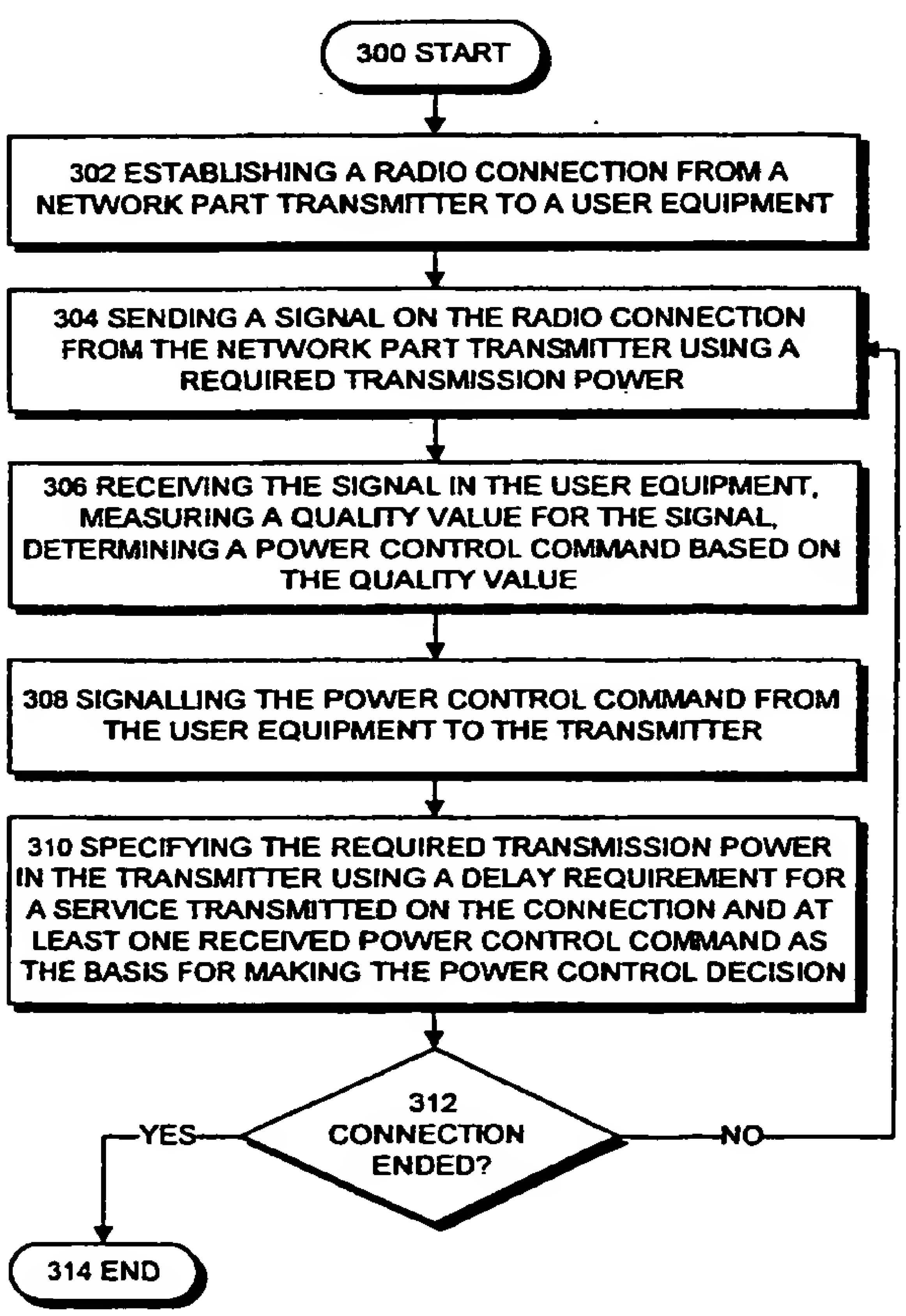
(54) Title: POWER CONTROL OF NETWORK PART TRANSMITTER IN RADIO SYSTEM



(57) Abstract: The invention relates to a method for performing power control of a network part transmitter in a radio system, and a network part using the method. The method comprises the steps of: (302) establishing a radio connection from the network part transmitter to a user equipment, (304) sending a signal on the radio connection from the network part transmitter using the transmission power required, (306) receiving the signal in the user equipment, measuring a quality value for the signal and determining a power control command based on the quality value, (308) signalling the power control command from the user equipment to the transmitter. The method also comprises the steps of: (310) specifying the power control required in the transmitter using a delay requirement of a service to be transferred over the radio connection and at least one received power control command as the basis for making the power control decision, (312 NO) continuing the method from another operation, i.e. (304) sending a signal on the radio connection from the network part transmitter using the transmission power required.

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POWER CONTROL OF NETWORK PART TRANSMITTER IN RADIO SYSTEM

FIELD OF THE INVENTION

The invention relates to a method for performing power control of a network part transmitter in a radio system and a network part in the radio system using the method.

BACKGROUND OF THE INVENTION

CDMA (Code Division Multiple Access) radio systems employ two types of power control, uplink power control and downlink power control. The uplink power control solves what is known as the near-far effect, i.e. a situation in which the transmission of a user equipment located far from the base station fades under the transmission of a user equipment near the base station if no power control is used.

The present invention relates to downlink power control, where power control is needed to reduce multiuser interference, or to reduce interference caused to other cells, and to compensate the interference caused by other cells.

For example, IS-95 radio system uses slow power control. The system is mainly intended for speech transmission. The base station periodically reduces the power control employed. A user equipment measures a frame error ratio and when the frame error ratio exceeds a predetermined limit, for example one percent, the user equipment requests for more transmission power from the base station. The power control is carried out at approximately 15 to 20 millisecond intervals (the frequency being 50 to 67 Hz), and the dynamic power control range is plus/minus six decibels.

More recent CDMA systems, such as the cdma2000 system or the WCDMA system, also use fast power control, and the power control can be carried out individually for each slot of the frame, and the dynamic power control range is fairly large. The frequency of fast power control is, for example, 800 Hz or 1600 Hz.

In recent mobile systems data is transferred in addition to speech, but the power control is not optimized in any way according to the requirements the services to be transferred set for the power control.

BRIEF DESCRIPTION OF THE INVENTION

It is an object of the invention to provide a method and an apparatus implementing the method, in which the power control of a transmitter is optimally implemented regarding the different services to be transferred over a radio connection. This is achieved with the method described below. The method concerned refers to a method for performing power control of a network part transmitter in a radio system, comprising the steps of establishing a radio connection from the network part transmitter to a user equipment, sending a signal on the radio connection from the network part transmitter using the transmission power required, receiving the signal in the user equipment, measuring a quality value for the signal and determining a power control command based on the quality value, signalling the power control command from the user equipment to the transmitter. The method comprises the steps of specifying the power control required in the transmitter using a delay requirement of a service to be transferred over the radio connection and at least one received power control command as the basis for making a power control decision, continuing to perform the method from another operation, i.e. sending a signal on the radio connection from the network part transmitter using the transmission power required.

The invention also relates to a network part of a radio system comprising a transmitter for establishing a radio connection to a user equipment, the radio connection being formed of signals, which are transmitted using the transmission power required, a receiver for receiving on a radio connection a signal sent by the user equipment, the signal comprising a power control command determined by the user equipment. The network part further comprises decision means for specifying the transmission power required in the transmitter using a delay requirement of a service to be transferred over the radio connection and at least one received power control command as the basis for making a power control decision.

The preferred embodiments of the invention are disclosed in the independent claims.

The idea of the invention is that according to studies carried out by the applicant an optimal power control method exists for each service to be transferred. The services to be transferred are distinguished from one another on the basis of a delay requirement thereof. It is decided in accordance with the delay requirement how frequently power control is actually performed. The

power control frequency does not therefore necessarily depend on the frequency of the power control commands to be received.

The method and the system of the invention provides at least such an advantage that the downlink capacity from the network part to the user equipment increases since the average signal-to-interference ratio thereof improves.

BRIEF DESCRIPTION OF THE DRAWINGS

In the following the invention will be described in greater detail by means of preferred embodiments with reference to accompanying drawings, in which

Figures 1 A and 1B illustrate an example of a system of the invention,

Figure 2 illustrates the operation of a transmitter and a user equipment of the invention,

Figure 3A is a flowchart showing a basic method of the invention,

Figures 3B and 3C are flowcharts complementing the basic method of the invention in Figure 3A with preferred embodiments, and

Figure 4 illustrates an example of the structure of a frame to be used on a radio connection.

DETAILED DESCRIPTION OF THE INVENTION

The invention can be used in all radio systems in which downlink power control is required and in which different services are transferred over a radio connection. A transmission channel can be formed by means of a time division, frequency division or code division multiple access method, for example. The invention also covers systems utilizing combinations of different multiple access methods. The examples describe how the invention is used in a universal mobile telecommunication system employing a wideband code division multiple access method, however, without restricting the invention thereto.

The structure of a universal mobile telecommunications system is described below with reference to Figures 1A and 1B. Figure 1B shows only the blocks that are essential for illustrating the invention, but it is obvious to those skilled in the art that a conventional mobile system also includes other functions and structures which do not have to be described in greater detail

herein. The main components of a mobile system are a core network CN, a UMTS terrestrial radio access network UTRAN and a user equipment UE. The interface between the CN and the UTRAN is referred to as Iu, and the air interface between the UTRAN and the UE is referred to as Uu.

The UTRAN consists of radio network subsystems RNS. The interface between RNSs is referred to as Iur. An RNS comprises a radio network controller RNC and one or more nodes B. The interface between an RNC and node B is referred to as Iub. The coverage area of node B, i.e. a cell, is denoted in Figure 1B by C.

The illustration in Figure 1A is extremely abstract, and is therefore further clarified in Figure 1B by showing which parts of the GSM system and the UMTS approximately correspond to one another. It should be noted that the mapping disclosed herein is not restrictive but only suggestive, since the responsibilities and functions of different parts of the UMTS are still being developed.

Figure 1B shows packet transmission through the Internet 102 from a computer 100 that is connected to a mobile system to a portable computer 122 connected to a user equipment UE. The UE can be, for example, a fixedly mounted, a vehicle-mounted or a hand-held portable terminal. The radio network infrastructure UTRAN comprises radio network subsystems RNS, or base station systems. An RNS includes a radio network controller RNC, or a base station controller, and at least one node B, or base station, controlled by the RNC.

The base station B comprises a multiplexer 114, transceivers 116 and a control unit 118 controlling the operation of the transceivers 116 and the multiplexer 114. The multiplexer 114 places traffic and control channels used by several transceivers 116 on the transmission connection Iub.

The transceivers 116 of the base station B are connected to an antenna unit 120, which implements a bidirectional radio connection Uu to the user equipment UE. The structure of the frames transmitted over the bidirectional radio connection Uu is accurately specified.

The base station controller RNC comprises a group switching field 110 and a control unit 112. The group switching field 110 is used to switch speech and data and to combine signalling circuits. The base station system formed of the base station B and the base station controller RNC also comprises a transcoder 108. The division of operations between the base station

controller RNC and the base station B and the physical structure of the elements may vary in different implementations. Typically the base station B manages the implementation of the radio path as described above. The base station controller RNC typically controls the following matters: radio resource management, control of inter-cell handover, power control, timing and synchronization, paging of user equipment.

The transcoder 108 is usually located as close to a mobile services switching centre 106 as possible since speech can be transmitted in mobile telephone system form between the transcoder 108 and the base station controller RNC, thus saving transmission capacity. The transcoder 108 adapts different digital speech coding forms used between a public switched telephone network and a mobile telephone network to each other, converting for example a 64 kbit/s fixed network form into some other (such as a 13 kbit/s) form of the cellular radio network, and vice versa. The required equipment are not described in greater detail herein. However, it can be pointed out that speech is the only type of data that is converted in a transcoder 122. The control unit 112 performs call control, mobility management, collection of statistical data and signalling.

The core network CN consists of the infrastructure of the mobile telephone system outside the UTRAN. Figure 1B shows the devices of the core network CN, such as the mobile services switching centre 106 and a gateway mobile services switching centre 104, which attends to the connections from the mobile telephone system to the outside world, in this case to the Internet 102.

An example of a frame structure that can be used on a physical channel is described with reference to Figure 4. Frames 440A, 440B, 440C, 440D are consecutively numbered from one to seventy-two, and they form a 720-millisecond superframe. The length of one frame 440C is 10 milliseconds. The frame 440C is divided into 16 slots 430A, 430B, 430C, 430D. The length of one slot 430C is 0.625 milliseconds. One slot 430C typically corresponds to one power control period, during which power is adjusted, for example, by one decibel upwards or downwards.

Physical channels are divided into different types, including common physical channels and dedicated physical channels.

The following transport channels are carried on the common physical channels: PCH (Paging Channel), BCH (Broadcast channel), RACH (Random Access Channel) and FACH (Forward Access Channel).

Dedicated physical channels comprise dedicated physical data channels (DPDCH) 410 and dedicated physical control channels (DPCCH) 412. The DPDCHs 410 are used to carry data 406 generated in layer two of OSI (Open Systems Interconnection) and in the layers above it, i.e. dedicated control channels. The DPCCHs 412 carry control information generated in layer one of the OSI. The control information comprises: pilot bits 400 used in channel estimation, feedback information (FBI) 408, transmit power control commands (TPC) 402, and optionally a transport format combination indicator (TFCI) 404. The transport combination format indicator 404 informs the receiver about the transport format of different transport channels, or the transport format combination used in said frame.

As Figure 4 shows, the downlink DPDCHs 410 and DPCCHs 412 are time-multiplexed into the same slot 430C. In the uplink direction the channels are, in turn, transmitted in parallel so that they are IQ/code-multiplexed (I = in-phase, Q = quadrature) into each frame 440C.

Figure 2 illustrates a transmitter 200 of the invention and a user equipment UE. The Figure shows only the basic functions of the radio transmitter 200. Different services to be placed in a physical channel include speech, data, moving or still video image, and system control channels, which are processed in a control part 208 of the radio transmitter. The Figure only shows the data processing. Different services require different source coding means, for example speech calls for a speech codec. However, for the sake of clarity the source coding means are not shown in Figure 2.

Packets from the computer 100 arrive at the radio network subsystem RNS as shown in Figure 1B, where channel coding is carried out in a channel coder 202. The channel coding is typically convolutional coding and different modifications thereof, such as turbo coding. Channel coding also includes different block codes, such as cyclic redundancy check (CRC) and the Reed-Solomon code.

Interleaving is not shown in Figure 2. The purpose of interleaving is to facilitate error correction. In interleaving signal bits are mixed together in a particular manner, and therefore a momentary fade over the radio path does not necessarily make the transmitted information impossible to identify.

The signal is spread by a spreading code and modulated in a block 204. The information to be transferred in the services is multiplied by the spreading code, whereby the relatively narrowband information is spread into a wide frequency band. Each connection Uu has a specific spreading code by which the receiver identifies the transmissions intended thereto. The pulse form of the signal obtained can be filtered. The signal is then modulated to a radio frequency carrier by multiplying it by a carrier. The signal obtained is ready to be sent to the radio path Uu irrespective of possible filterings and power gains.

Typically, the maximum number of mutually orthogonal spreading codes simultaneously in use is two hundred and fifty-six. For example, when a 4.096 megachip carrier is used in the UMTS, the spreading factor 256 corresponds to a transmission rate of thirty-two kilobits/second. Correspondingly, the highest practical transmission rate is achieved with the spreading factor four, the data transmission rate then being two thousand and fourty-eight kilobits/second. The transmission rate on the channel varies stepwise between 32, 64, 128, 256, 512, 1024 and 2048 kbit/s, while the spreading factor correspondingly varies between 256, 128, 64, 32, 16, 8 and 4. The transmission rate obtained by the user depends on the channel coding used. For example, while using 1/3 convolution coding the data transmission rate of the user is approximately one third of the actual data transmission rate of the channel. The spreading factor may indicate the length of the spreading code. For example the spreading code (1) corresponds with spreading factor one. Spreading factor two has two mutually orthogonal spreading codes (1,1) and (1,-1). Furthermore, spreading factor four has four mutually orthogonal spreading codes: (1,1,1,1), (1,1,-1,-1) beneath the upper level spreding code (1,1) and spreading codes (1,-1,1,-1) and (1,-1,-1,1) beneath the upper level of the second spreading code (1,-1). The spreading codes at a certain level are generally mutually orthogonal, for example when using the Walsh-Hadamard code sets.

The modulated signal is supplied to radio frequency parts 210 comprising a power amplifier 212. The radio-frequency parts 210 may also comprise filters that restrict the bandwidth. An analogue radio signal 240 is thereafter transmitted through the antenna 214 to the radio path Uu.

The radio receiver 220 is typically a Rake receiver. An analogue radio-frequency signal 240 is received from the radio path Uu by an antenna

222. The signal 240 is supplied to radio-frequency parts 224 comprising a filter which blocks frequencies outside the desired frequency band. The signal is thereafter converted in a demodulator 226 into an intermediate frequency or directly to a baseband, in which mode the converted signal is sampled and quantized.

As the signal has propagated through several paths, the multipath-propagated signal components are preferably combined in a block 226 comprising several Rake fingers according to the prior art.

A rowing Rake finger searches for delays for each multipath-propagated signal component. After locating the delays, each different Rake finger is allocated to receive a specific multipath-propagated signal component. In reception a received signal component is correlated by the spreading code used, which has been delayed by the delay located for the multipath concerned. The different demodulated and despread multipath-propagated components of the same signal are combined so as to obtain a stronger signal.

The signal is thereafter supplied to a channel decoder 228 decoding the channel coding used in the transmission, for example block coding and convolutional coding. Convolutional coding is preferably decoded by a Viterbi decoder. The data obtained and originally transmitted is supplied to a computer 122 connected to the user equipment UE for further processing.

The quality value of the received signal is measured in a block 230. The measurements are associated with the channel conditions, such as channel parameters, signal reception power, bit-error rate, SINR ratio (Signal/Interference+Noise Ratio), SIR ratio (Signal/Interference Ratio), C/I ratio (Carrier/Interference Ratio) or with any other known method for measuring channel quality.

The downlink power control can be carried out, for example, so that a SIR target set by the network part is set for the connection. If the user equipment UE detects that the SIR target set cannot be achieved, the user equipment UE signals a transmitter 232 thereof by sending a power control command to the network part RNS. The power control commands may indicate an absolute power value, but generally they are proportional, i.e. the power control command indicates for example that the power has to be adjusted by a certain amount of decibels upwards or downwards.

The transmitter 232 of the user equipment UE sends a power control command 250 to the network part RNS using an antenna 234. In the example shown in Figure 4 the power control command is placed in the transmit power control command 402 of the frame, or is transferred using the uplink DPCCH.

The network part RNS comprises a receiver 216 receiving a power control command 250 sent by the user equipment UE using an antenna 218 thereof. The power control command is then processed in decision means 208 of the network part RNS, in which the transmission power needed in the transmitter 2 is specified. The power amplifier 212 is controlled to send the signal to the user equipment UE at the desired power.

In accordance with the invention the decision means 208 use on a radio connection 240 the delay requirement of the service to be transferred and at least one received power control command as the basis for the power control decision.

The simulations carried out by the applicant show that fast downlink power control increases the system capacity when transferring real time services, such as speech. The studies made by the applicant correspondingly reveal that when non-real time services are transferred it is preferable for the system capacity to use slow downlink power control, since the capacity can be increased by as much as 2.5 decibels. The studies made on non-real time services are published in an article by Mika Raitola and Harri Holma: Wideband CDMA Packet Radio With Hybrid ARQ in publication IEEE Fifth International Symposium on Spread Spectrum Techniques & Application, IEEE ISSSTA '98 Proceedings, ISBN: 0-7803-4281-X, which article is incorporated herein by reference.

An example of non-real time services is packet-switched data transmission, where a connection is established between users by transferring data in packets that include address and control information/data in addition to actual data. Packet transmission frequently uses a basic form or a more advanced form of an ARQ protocol. The ARQ (Automatic Repeat Request) protocol refers to a procedure in which the retransmission of the data to be transferred can improve the reliability of the data to be transferred by increasing the bit error rate thereof. A more advanced form of the ARQ basic protocol is a hybrid ARQ, which employs a combination of the ARQ and an FEC (Forward Error Correction). The FEC indicates that the data to be transferred

is coded with a coding that corrects errors, i.e. when using the terms in Figure 2 the FEC refers to channel coding that is carried out in a channel coder 202.

The maximum delay of the service becomes shorter when the ARQ protocol is used together with fast power control than if the ARQ protocol is used without fast power control. One reason for this is that when the channel fades, fast power control allows to rapidly increase the transmission power. The use of slow power control would result in retransmitting the data. Retransmission increases time diversity, which in turn increases capacity. The delays vary more extensively when slow power control is used than when fast power control is used.

Let us assume that the frame error ratio of packet transmission is ten percent after the first data transmission, and that the frame errors are uncorrelated. These assumptions are adequately valid in connection with fast power control. When slow power control is used for slow moving user equipment (the rate below 10 km/h), the frames are correlated, and longer delays occur during channel fadings. Table 1 shows the delay division of packets when fast power control is used. It is assumed in the table that each retransmission adds three frames, i.e. 30 milliseconds of additional delay, and that no errors occur on the feedback channel.

Number of retransmissions	Probability	Delay
1	90 %	10 ms
2	10 %	40 ms
3	1 %	70 ms
4	0.1 %	100 ms
5	10^{-4}	130 ms
6	10^{-5}	170 ms
7	10^{-6}	200 ms

Table 1

The studies made by the applicant show that the optimal E_b/N_0 target using fast power control is very narrow, whereas slow power control provide a very even capacity curve. The operation points of slow power control can be decreased without dramatically affecting the performance. This provides flexibility for the downlink load control.

Furthermore, the studies carried out by the applicant show that if fast power control is not used then averagely lower transmission powers are required. The variations in transmission power need not be considered either. Slow power control sets lower requirements for the power amplifier of the base station transmitter, since the headroom required by fast power control is not needed in the power amplifier. As the transmission power on the channel generally varies, for example, from minus three to plus three decibels, the transmission power has to be increased up to plus fifteen decibels during channel fading, when fast power control is used. Headroom refers to the difference in variation between an optimal transmission power and an average transmission power.

In the following, the operations to be performed in the power control method of the invention are presented with reference to Figure 3A. The implementation of the method starts from block 300. The radio connection 240 is formed in block 302 from the network part RNS transmitter 200 to the user equipment UE.

A signal is sent over the radio connection 240 in block 304 from the network part RNS transmitter 200 using the required transmission power. In the beginning of the connection the transmission power may be a default.

In block 306 the signal is received in the user equipment UE, and a quality value is measured for the signal in accordance with one of the above described prior art methods. The quality value determines the power control command, such as "add transmission power by one decibel" or "reduce transmission power by one decibel". In block 308 the power control command is signalled from the user equipment UE to the network part RNS transmitter.

The required transmission power needed in the transmitter is specified in block 310 using the delay requirement of the service to be transferred on the radio connection and at least one received power control command as the basis for making the power control decision. The operation of this block is explained in greater detail in Figure 3B.

In block 312 it is checked whether the radio connection 240 is still in operation. If the radio connection does not operate any longer, then the process proceeds to block 314, where the method is ended. Since the method described performs power control on one radio connection only, and since a network part transmitter 200 may simultaneously have various connections to different user equipment, it is obvious that the method of the invention can be

carried out in parallel for various connections simultaneously in one transmitter 200.

If the radio connection is not ended, then the process proceeds from block 312 to block 304, where the method is carried out from another operation, i.e. the following signal is sent on the radio connection 240 from the network part RNS transmitter 200 using the transmission power required. Here the term "transmission power required" refers to the transmission power specified in block 310 particularly in accordance with the invention.

In the following, the operation of block 310 will be explained in greater detail with reference to Figure 3B. The operation of block 310 is formed of the operations of blocks 320, 322, 326 and 330.

In block 320 a choice is made according to the type of service. When dividing the services the delay requirement thereof is the determining factor. The service becomes more real time the shorter the delay requirement is.

When a short delay real time service 322 is concerned, for example speech transmission or short delay real time data, the process proceeds to block 324 according to which fast power control is used, and in which the transmission power required is specified after the reception of each power control command.

When a long delay real time service is concerned, for example fast delay real time data, then the process proceeds to block 326 according to which slower power control than the fast power control is used, and in which the transmission power required is not changed after each received power control command. It is obvious for those skilled in the art that the frequency of the power control to be performed can then be arranged to suit the nature of the data to be transferred.

When a non-real time service is concerned, such as the use of a web browser or one-directional data transmission, the process proceeds to block 330, according to which slow power control is used, and in which the transmission power required is not changed after each received power control command.

It is difficult to precisely define "fast power control", "slower than fast power control" and "slow power control", since the limits thereof depend on the radio system to be examined. However, it can be noted that for example in the universal mobile system the frequency of fast power control is approximately

800 to 1600 Hz, i.e. the maximum power control is performed separately for each frame slot used on the radio connection. Correspondingly, the frequency of slow power control varies between 1.4 to 100 Hz, i.e. the required transmission power is changed at the most for each frame or super-frame to be used on the radio connection. The power control which is slower than the fast power control may vary between these extreme ends, or between 100 to 800 Hz.

It can be noted in this context that the invention can be employed in such systems in which the signalling of a physical layer supports fast power control only. When slower than fast power control is desired, a quantity describing an average value is calculated from a certain amount of fast power control power control commands, the quantity then being used as a basis for making the power control decision. For example in the universal mobile system, the value of one slow power control command regarding one frame can be calculated from the power control commands regarding all slots of said frame, i.e. from 16 power control commands in all. The situation can for instance be such that nine commands include the command "increase transmission power by one decibel" and seven commands include the command "reduce transmission power by one decibel". In such a case the command "increase transmission power by two decibels" could be considered as an average command. Depending on the power amplifier properties, certain limits might have to be set for power control, since the transmission power cannot exceed a certain limit, or be lower than a certain limit. If the power range is not sufficient then the connection is disconnected, or in the case of packet transmission a larger number of retransmissions is performed. Another way to solve the problem is to use handover.

Figure 3C illustrates the effect of a service to be transferred on the error correction strategy to be used. The measures to be carried out 320, 340, 342 and 344 are included in block 304 of Figure 3A, in which a signal to be transmitted is formed and transmitted.

In block 320 a choice is made according to the type of service.

When a short delay real time service 322 is concerned, the information in such a service is typically protected with an error correcting FEC coding in accordance with block 340. Fast power control allows to guarantee an adequate quality for each FEC coding/interleaving sequence.

When a long delay real time service 326 is concerned, the information included in the service is protected in accordance with block 342 with at

least an error correcting FEC coding, and if necessary retransmissions are implemented using an ARQ protocol. The power control may be slower than fast power control, since time diversity created by retransmissions can be utilized against a fading channel. The same procedure may be used when non-real time services are concerned, as no fixed delay requirements are set thereto, in which case random fairly long delays can be tolerated.

The performance of non-real time services are measured in accordance with the total performance, and not according to the delay at particular times. If the channel has faded but the channel conditions have not changed, then the only way to pass the data is to adequately add transmission power.

One way to reduce the repeated retransmissions of the same data packet, is to use soft combining of the transmitted data packets in accordance with block 344. The soft combining can be implemented either by combining data packets or by employing maximal ratio combining. The soft combining is disclosed in publications WO 98/49796 and WO 98/49797, which are incorporated herein by reference.

In a preferred embodiment at least one dedicated physical channel is allocated to the user equipment UE on the radio connection 240 and at least a part of a shared physical channel that is time-divisionally shared. In this case the downlink connection has a dedicated channel possibly with a small transmission capacity continuously in use, and if necessary a shared channel in use. The shared channel is employed in bursty data transmission when a large data transmission capacity is needed. The shared channel may have various users, and for instance a transportation format combination indicator 404 indicates who is liable to use the shared channel at a particular time. The soft combining described can also be used on a time-divisionally shared physical channel. The power control of the time-divisionally shared physical channel is carried out on the basis of the power control decision of the dedicated physical channel. The power control of the shared physical channel is naturally user-specific.

In the radio system according to Figure 2 the invention assumes that the transmitter 200 comprises decision means 208 for specifying the transmission power required in the transmitter 200 using the delay requirement of the service to be transferred on the radio connection 240 and at least one received power control command as the basis for the power control decision.

The invention is preferably implemented by software, whereby the network part RNS, for example the transmitter 200, includes a microprocessor, in which the decision means are implemented as operating software. The invention can obviously also be implemented using apparatus solutions providing the required functionality, such as the ASIC (Application Specific Integrated Circuit) or as separate logic.

Even though the invention has been described above with reference to the example of the accompanying drawings, it is obvious that the invention is not restricted thereto but can be modified in various ways within the scope of the inventive idea disclosed in the attached claims.

CLAIMS

1. A method for performing power control of a network part transmitter in a radio system comprising the steps of:

(302) establishing a radio connection from the network part transmitter to a user equipment,

(304) sending a signal on the radio connection from the network part transmitter using the transmission power required,

(306) receiving the signal in the user equipment, measuring a quality value for the signal and determining a power control command based on the quality value,

(308) signalling the power control command from the user equipment to the transmitter,

characterized by

(310) specifying the power control required in the transmitter using a delay requirement of a service to be transferred over the radio connection and at least one received power control command as the basis for making a power control decision,

(312 NO) continuing to perform the method from another operation, i.e. (304) sending a signal on the radio connection from the network part transmitter using the transmission power required.

2. A method as claimed in claim 1, **characterized** in that short delay real time services (322) use fast power control (324), in which the transmission power required is specified after each received power control command.

3. A method as claimed in claim 2, **characterized** in that the data included in the service is protected by an error correcting FEC coding (340).

4. A method as claimed in claim 1, **characterized** in that long delay real time services (326) use slower power control (328) than the fast power control, in which the transmission power required is not changed after each received power control command.

5. A method as claimed in claim 1, **characterized** in that non-real time services (330) use slow power control (332) in which the transmission power required is not changed after each received power control command.

6. A method as claimed in claim 4 or 5, **characterized** in that the information included in the service is protected using the error correcting FEC coding, and retransmissions are implemented using (342) an ARQ protocol if needed.

7. A method as claimed in claim 6, **characterized** by using soft combining (344) of data packets retransmitted in accordance with the ARQ protocol and included in the service for reducing the number of retransmissions.

8. A method as claimed in claim 7, **characterized** in that at least one dedicated physical channel is allocated to the user equipment on the radio connection and at least a part of a shared physical channel that is time-divisionally shared, and that the soft combining of retransmitted data packets is used on the time-divisionally shared physical channel.

9. A method as claimed in claim 1, **characterized** in that at least one dedicated physical channel is allocated to the user equipment on the radio connection and at least a part of the shared physical channel that is time-divisionally shared, and that the power control of the time-divisionally shared physical channel is carried out on the basis of the power control decision of the dedicated physical channel.

10. A method as claimed in claim 1, **characterized** in that the power control command is sent separately for each frame slot to be used on the radio connection.

11. A method as claimed in claim 4 or 5, **characterized** in that the transmission power required is changed less frequently than each frame slot to be used on the radio connection.

12. A method as claimed in claim 11, **characterized** in that the transmission power required is changed at the most for each frame to be used on the radio connection.

13. A method as claimed in claim 11, **characterized** in that a quantity describing an average value is calculated from a particular number of power control commands, the quantity then being used as a basis for making the power control decision.

14. A network part of a radio system comprising

a transmitter (200) for establishing a radio connection (240) to a user equipment (UE), the radio connection (240) being formed of signals, which are transmitted using the transmission power required,

a receiver (216) for receiving on a radio connection (250) a signal sent by the user equipment (UE), the signal comprising a power control command determined by the user equipment (UE),

characterized by comprising

decision means (208) for specifying the transmission power required in the transmitter (200) using a delay requirement of a service to be transferred over the radio connection (240) and at least one received power control command as the basis for making the power control decision.

15. A network part as claimed in claim 14, **characterized** in that the decision means (208) use fast power control for short delay real time services, in which the transmission power required is specified after each received power control command.

16. A network part as claimed in claim 15, **characterized** in that the transmitter (200) also comprises means (202) for protecting the information included in the service using an error correcting FEC coding.

17. A network part as claimed in claim 14, **characterized** in that the decision means (208) use slower power control than the fast power control for long delay real time services, in which the transmission power required is not changed after each received power control command.

18. A network part as claimed in claim 14, **characterized** in that the decision means (208) use slow power control for non-real time services, in which the transmission power required is not changed after each received power control command.

19. A network part as claimed in claim 17 or 18, **characterized** in that the transmitter (200) also comprises means (202) for protecting the information included in the service using the error correcting FEC coding, and means (208) for carrying out retransmissions using an ARQ protocol if needed.

20. A network part as claimed in claim 19, **characterized** in that the transmitter (200) also comprises means (208) for implementing soft combining of data packets retransmitted in accordance with the ARQ protocol and included in the services for reducing the number of retransmissions.

21. A network part as claimed in claim 20, **characterized** in that at least one dedicated physical channel and at least a part of a shared physical channel that is time-divisionally shared are allocated to the user equipment (UE) on the radio connection (240), and the means (208) for carry-

ing out soft combining of the retransmitted data packets also perform the soft combining of the retransmitted data packets on the time-divisionally shared physical channel.

22. A network part as claimed in claim 14, **characterized** in that at least one dedicated physical channel and at least a part of a shared physical channel that is time-divisionally shared are allocated to the user equipment (UE) on the radio connection (240), and the decision means (208) also carry out the power control of the time-divisionally shared physical channel on the basis of the power control decision of the dedicated physical channel

23. A network part as claimed in claim 14, **characterized** in that the receiver (200) receives the power control command separately for each frame slot to be used on the radio connection (240).

24. A network part as claimed in claim 17 or 18, **characterized** in that the decision means (208) change the transmission power required less frequently than for each frame slot to be used on the radio connection (240).

25. A network part as claimed in claim 24, **characterized** in that the decision means (208) change the transmission power required at the most for each frame to be used on the radio connection (240).

26. A network part as claimed in claim 24, **characterized** in that the decision means (208) calculate a quantity describing an average value from a certain number of power control commands, the quantity thereafter being used as a basis for making the power control decision.

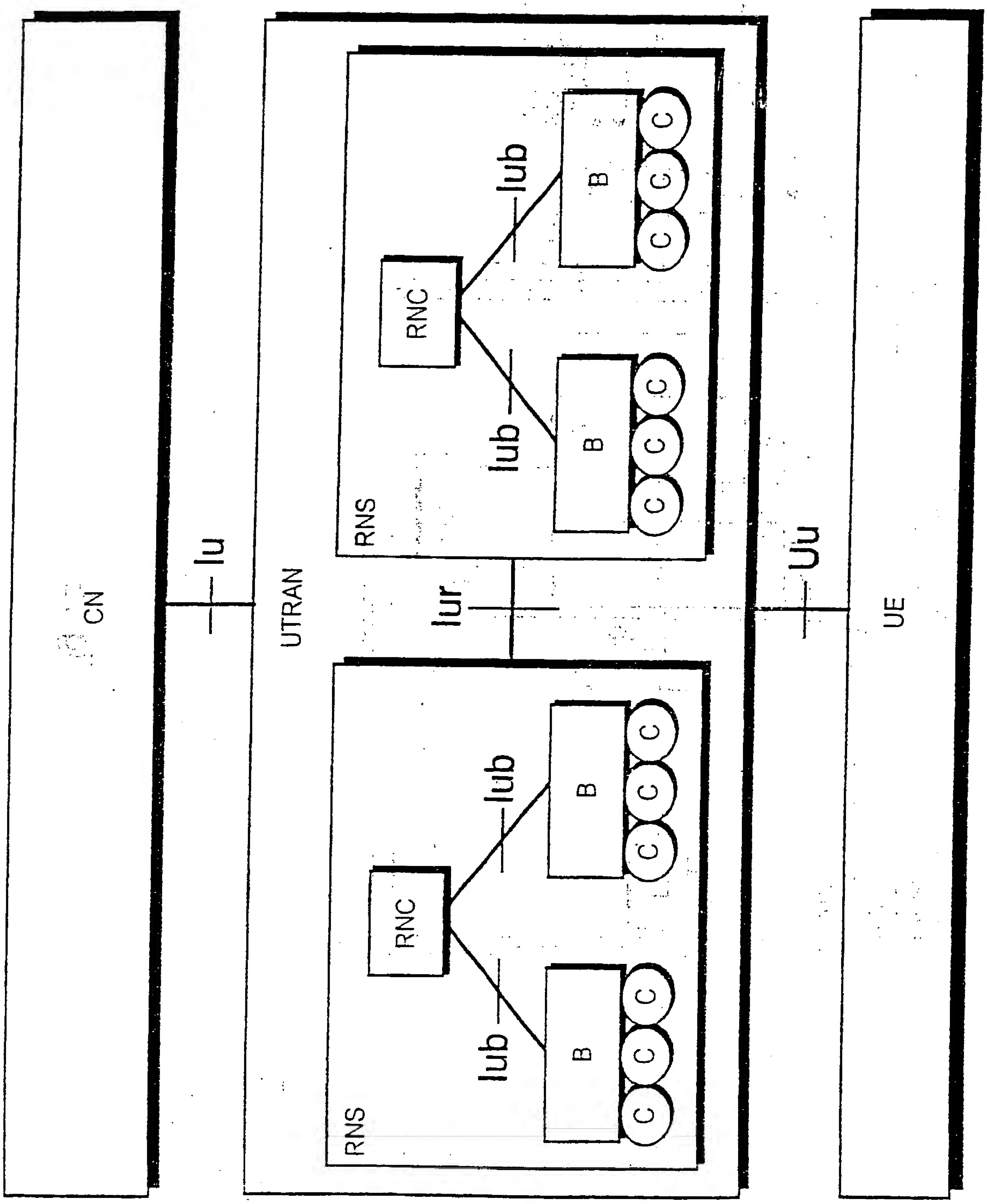

Fig 1A

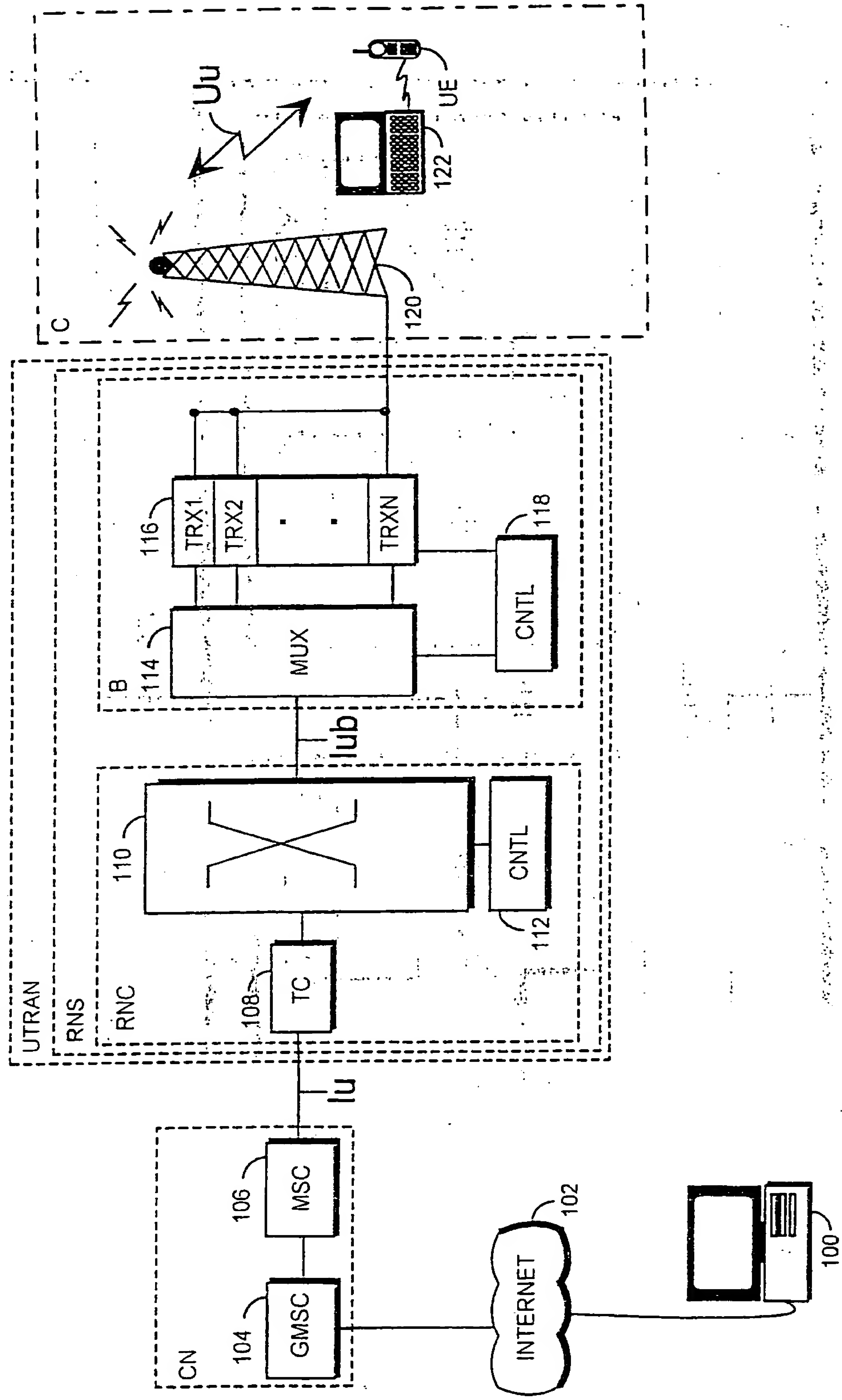
C
Uu
UE
122
120
UTRAN
RNS
RNC
B
116
TRX1
TRX2
TRXN
118
CNTL
114
MUX
Iub
110
CNTL
112
108
TC
Iu
CN
106
MSC
104
GMSC
INTERNET
102
100

Fig 1B

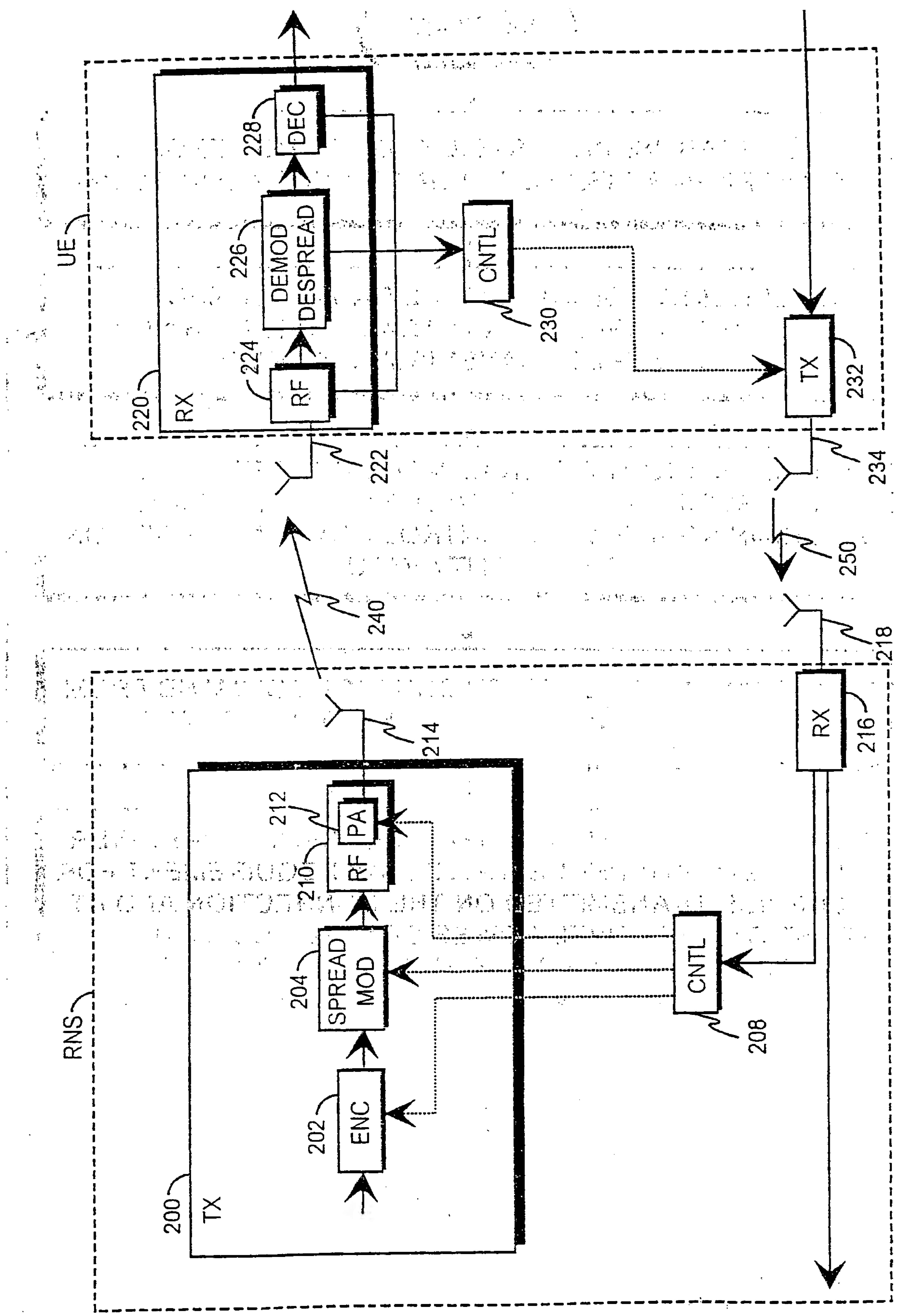
UE
RX
220
RF
224
DEMOD DESPREAD
226
DEC
228
CNTL
230
TX
232
222
234
240
250
218
RNS
TX
200
ENC
202
SPREAD MOD
204
RF
210
PA
212
214
CNTL
208
RX
216

Fig 2

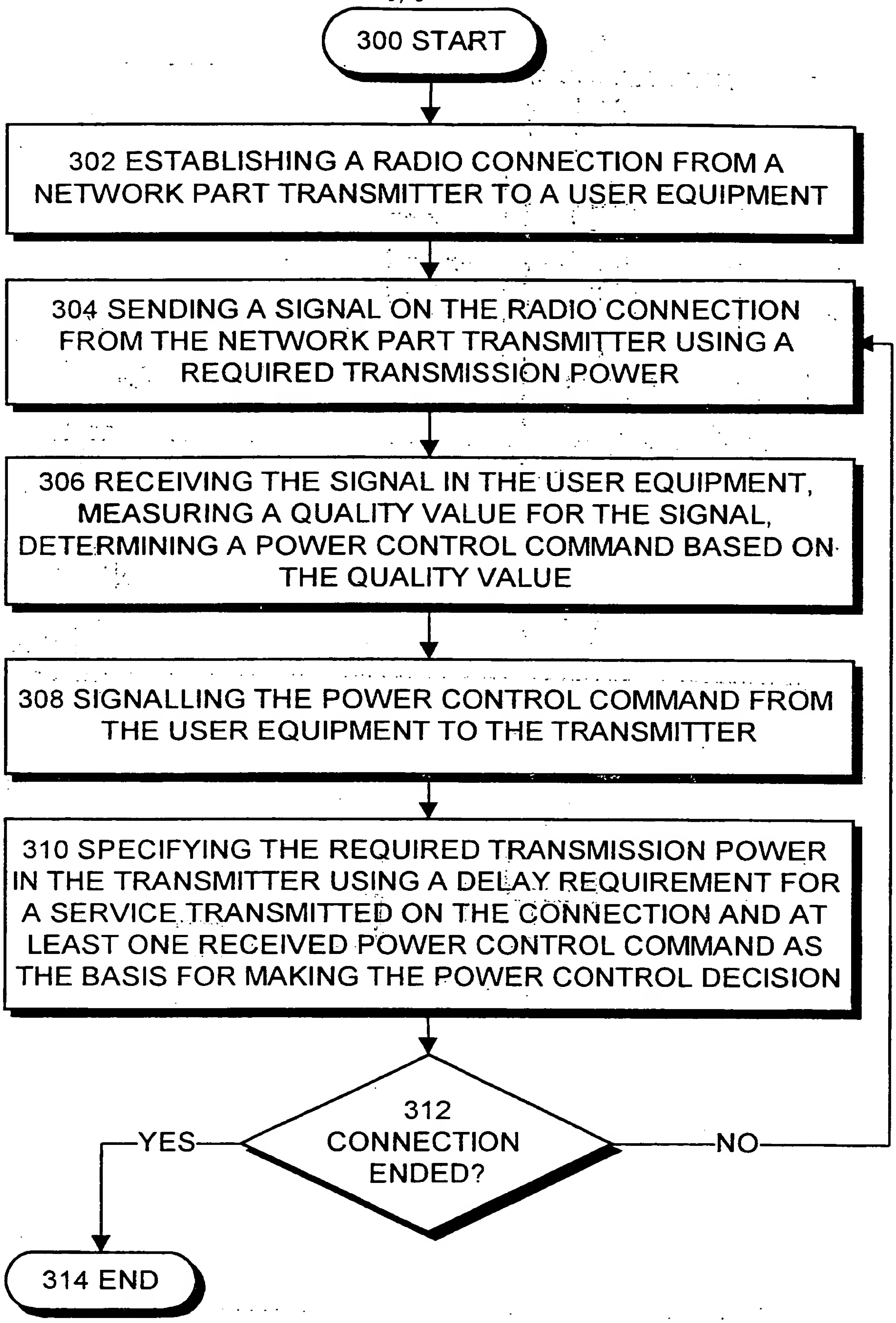
300 START
302 ESTABLISHING A RADIO CONNECTION FROM A NETWORK PART TRANSMITTER TO A USER EQUIPMENT
304 SENDING A SIGNAL ON THE RADIO CONNECTION FROM THE NETWORK PART TRANSMITTER USING A REQUIRED TRANSMISSION POWER
306 RECEIVING THE SIGNAL IN THE USER EQUIPMENT, MEASURING A QUALITY VALUE FOR THE SIGNAL, DETERMINING A POWER CONTROL COMMAND BASED ON THE QUALITY VALUE
308 SIGNALLING THE POWER CONTROL COMMAND FROM THE USER EQUIPMENT TO THE TRANSMITTER
310 SPECIFYING THE REQUIRED TRANSMISSION POWER IN THE TRANSMITTER USING A DELAY REQUIREMENT FOR A SERVICE TRANSMITTED ON THE CONNECTION AND AT LEAST ONE RECEIVED POWER CONTROL COMMAND AS THE BASIS FOR MAKING THE POWER CONTROL DECISION
312 CONNECTION ENDED?
YES
NO
314 END

Fig 3A

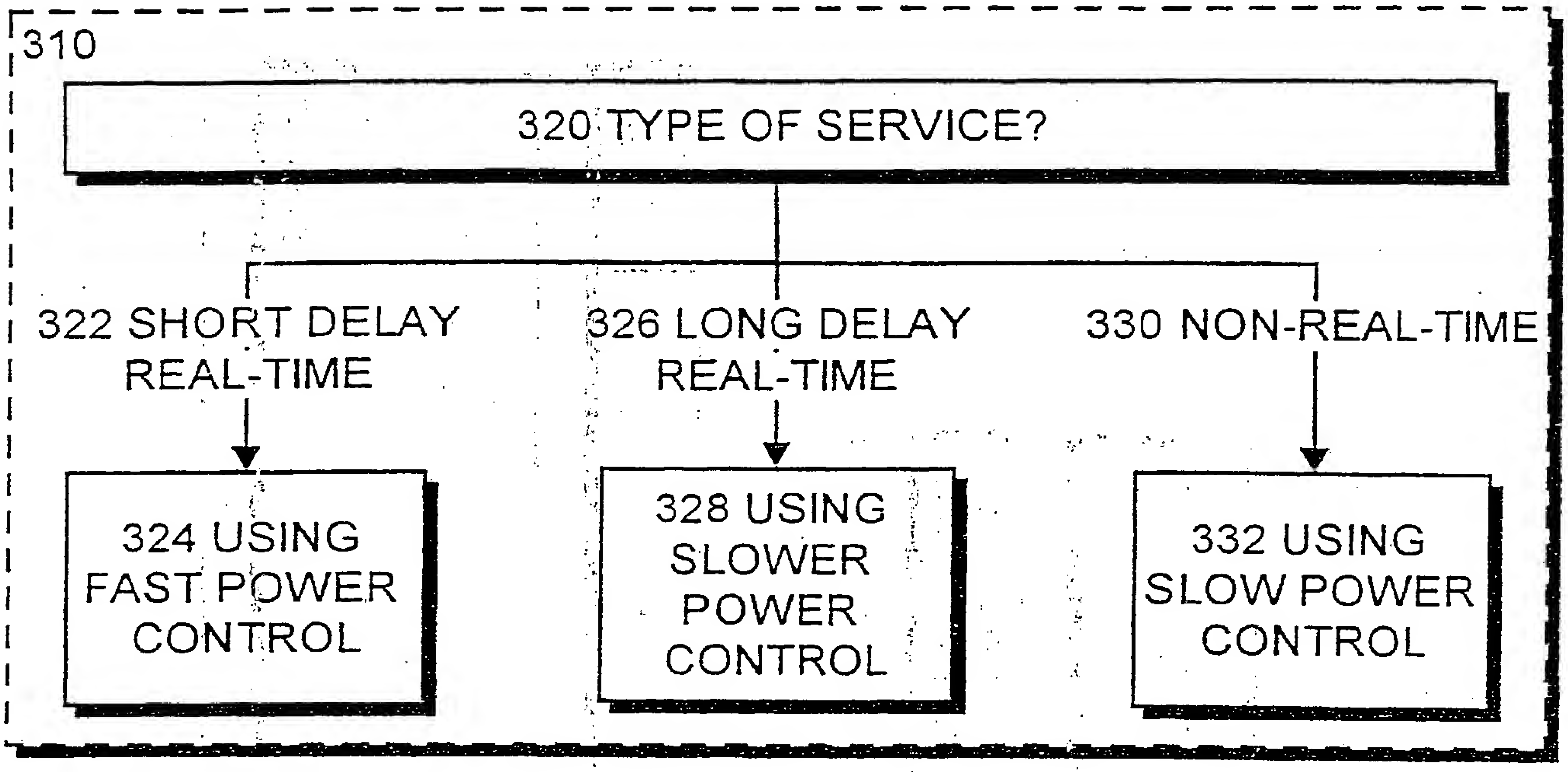
310
320 TYPE OF SERVICE?
322 SHORT DELAY REAL-TIME
326 LONG DELAY REAL-TIME
330 NON-REAL-TIME
324 USING FAST POWER CONTROL
328 USING SLOWER POWER CONTROL
332 USING SLOW POWER CONTROL

Fig 3B

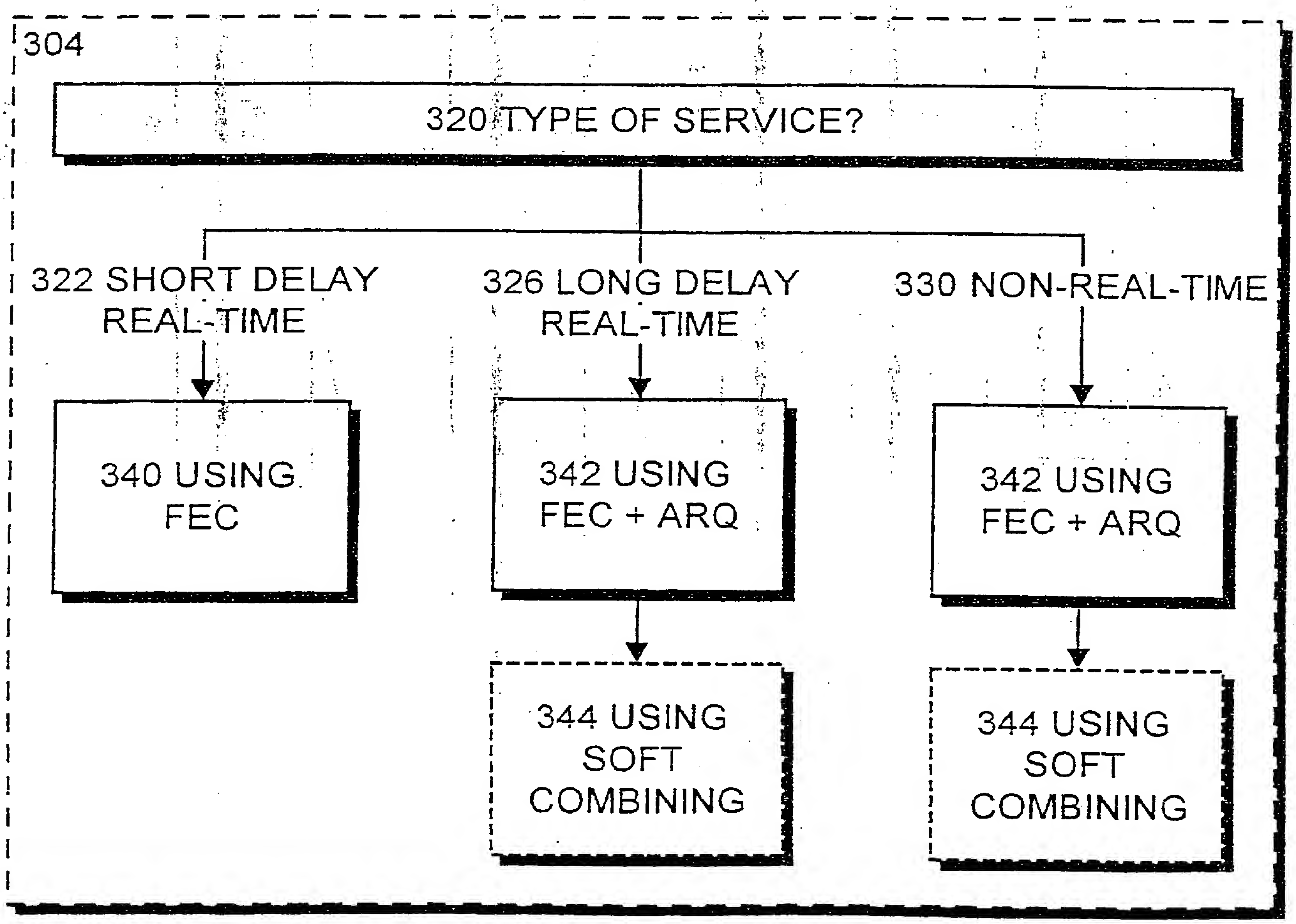
304
320 TYPE OF SERVICE?
322 SHORT DELAY REAL-TIME
326 LONG DELAY REAL-TIME
330 NON-REAL-TIME
340 USING FEC
342 USING FEC + ARQ
342 USING FEC + ARQ
344 USING SOFT COMBINING
344 USING SOFT COMBINING

Fig 3C

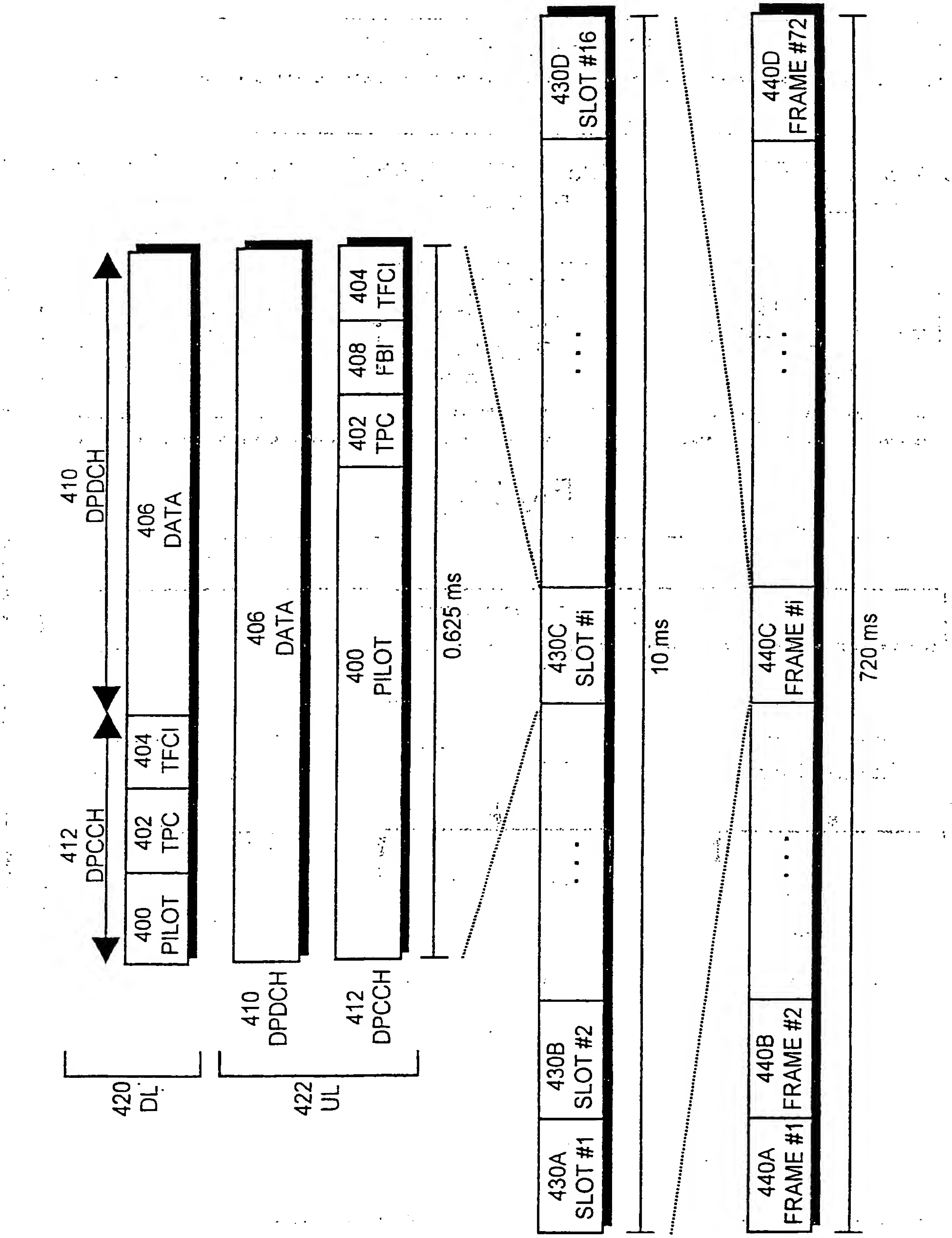
420 DL
422 UL
410 DPDCH
412 DPCCH
400 PILOT
402 TPC
404 TFCI
406 DATA
410 DPDCH
412 DPCCH
406 DATA
400 PILOT
402 TPC
408 FBI
404 TFCI
0.625 ms
430A SLOT #1
430B SLOT #2
430C SLOT #i
430D SLOT #16
10 ms
440A FRAME #1
440B FRAME #2
440C FRAME #i
440D FRAME #72
720 ms

Fig 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 00/00509

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H04B 7/005, H04Q 7/30
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H04B, H04Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	IEEE Proceedings, Sixth International Symposium on Modeling, Analysis and Simulation of Computer and Telecommunication Systems (1998), Anurag Bhargava et al: "D2PAMN: Distributed Dynamic Power and error control Algorith for Mobile Networks", pages 295-300,	1-9,14-22
A		10-13,23-26
	--	
Y	IEEE Proceedings, 5th Int. Symp. on Spread Spectrum Techniques and applications, (1998), Mika Raitola et al: "Wideband CDMA Packet Data with Hybrid ARQ", pages 318-322	1-9,14-22
A		10-13,23-26
	--	

[X] Further documents are listed in the continuation of Box C. [X] See patent family annex.

* Special categories of cited documents:
"A" document defining the general state of the art which is not considered to be of particular relevance
"E" erlier document but published on or after the international filing date
"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)
"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
20 Sept 2000	27-09-2000
Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Bo Gustavsson/AE Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

International application No.
PCT/FI 00/00509

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 9907170 A2 (NOKIA TELECOMMUNICATIONS OY), 11 February 1999 (11.02.99), page 11, line 8 - line 25; page 18, line 25 - line 33, figure 11	1-7,14-20
	--	
A	WO 9858461 A1 (TELEFONAKTIEBOLAGET LM ERICSSON), 23 December 1998 (23.12.98), page 9, line 24 - page 13, line 4	1-26
	--	
A	48th IEEE Vehicular Technology Conference, Volume 3, 1998, Y.F. Melanie Wong et al., "Analysis of Wireless Multimedia DS/CDMA System Hybrid ARQ, Diversity and Power Control" page 2197 - page 2201	1-26
	--	
P,A	WO 9953701 A2 (NOKIA TELECOMMUNICATIONS OY), 21 October 1999 (21.10.99), see the whole document	1-26
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INTERNATIONAL SEARCH REPORT
Information on patent family members

01/08/00

International application No.
PCT/FI 00/00509

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9907170 A2	11/02/99	AU 8543898 A	22/02/99
		FI 104143 B	00/00/00
		FI 973169 A	01/02/99
		ZA 9806804 A	02/02/99
WO 9858461 A1	23/12/98	AU 8050198 A	04/01/99
		EP 0990314 A	05/04/00
WO 9953701 A2	21/10/99	AU 3037999 A	01/11/99
		FI 980702 A	28/09/99

Form PCT/ISA/210 (patent family annex) (July 1992)